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VARIATIONS OF GLACIERS.¹ II.²

THE first annual report of the *International Committee on Glaciers* has been published,³ and gives the state of glaciers in various regions of the world so far as reports have been received, with references to some of the original sources of information. This committee was appointed to stimulate and record observations on glaciers. The following is a summary of the report.

No glaciers, except those of the Alps, have been under observations long enough to yield very definite results; but these have shown a decided periodicity of about thirty-five years in their size; it is not improbable that glaciers in other regions may have a similar periodicity.

A *period* is the time during which a glacier goes through all its changes; it begins at a *minimum*, continues through the *phase of increase*, the *maximum*, and the *phase of decrease*, and ends at the following minimum.

The Alps.—The glaciers of this chain were for the most part in the phase of decrease from 1855 to 1875; since then a number of glaciers have entered the phase of increase, namely: all those of the Mont Blanc group, about a half of those of the Valais, not more than a quarter of those of the Bernese Oberland, a few in the eastern Alps, and none east of the Brenner pass; so that the phase of increase at the end of the nineteenth century has been limited and not general; and observations from 1893 to 1895 show that many of the glaciers which have recently been advancing are again in retreat.

Of the glaciers observed in the Eastern Alps in 1895 there were about fourteen increasing, twenty decreasing, and five stationary.

¹ Read before the Geological Society of America at the Washington meeting, 1896.

² See this JOURNAL, Vol. III, pp. 278–288.

³ Archives des Sciences, Vol. II, pp. 129–147, Geneva, 1896.

In the Swiss Alps where observations have been more general and have extended over a longer period, we find, in 1895, twelve glaciers increasing, forty-eight decreasing, seven stationary, and ten doubtful; in addition, several glaciers were measured for the first time in 1895, so that we may expect results from a still larger number in the future.

The great majority of the glaciers of the French Alps are decreasing in size.

The Pyrenees.—The eleven glaciers of this chain for which we have results, show five increasing, five decreasing and one stationary. Considerably over 200 French glaciers are now under observation.

The Caucasus.—A number of glaciers in this chain have been observed, showing a fairly general retreat; in 1894 some of the névé fields were growing larger.

Central Asia.—The glaciers are mostly in the Pamir, the Tian-schan, and the Alai mountains. They are of considerable size, and appear to be pretty generally in retreat.

Nova Zembla.—Glaciation is increasing.

The Scandinavian Alps.—The Norwegian glaciers do not show evidence of having participated in the great retreat of 1850–1880. The state of the vegetation in the immediate neighborhood of the glaciers shows that in many cases they have either kept or reattained the dimensions they had a century or so ago. There have been some advances and some slight recent retreats; there are no indications of any present advance.[†]

The Swedish glaciers are too little known to yield any definite results as yet.

The Himalaya.—Sir W. M. Conway reports the glaciers of this range in retreat, so far as observed, with the exception of the Bagrot glacier, which is beginning to advance.

The New Zealand Alps.—Considerable attention has of late been given the fine glaciers of this region. They seem to be either stationary or decreasing.

[†] See especially *Beobachtungen üb Gletscherschwankungen in Norwegen*, by E. RICHTER. Petermann's Mitth. Vol. XLII, p. 107.

*United States of America.*¹—The glaciers of the United States have for the most part been so infrequently visited that the information regarding them is very meager. Professor Russell, in 1892, collected the evidence showing that in general they are retreating.² A few glaciers, however, give evidence of being in a state of advance.

The Malaspina glacier occupies a large plateau on the southern side of the St. Elias Mountain range. Though in general receding, a part of it near the Yahtse River was advancing and destroying trees in 1886.³ Professor Russell states that the southeastern portion of the same glacier near Point Manby has recently advanced a distance of 500 meters and again retreated.⁴

The Frederika glacier, in the interior of Alaska (long. 142° 35' N., lat. 61° 40' W.) was the only glacier in its neighborhood advancing in 1891.⁵

Mr. John Muir writes me that a glacier at the southern end of the Fairweather range was advancing and destroying trees when he visited it in 1880.

Muir glacier, Alaska, which has in general been receding for the last hundred years or more, made a temporary advance between 1890 and 1892 of nearly 300 meters, but in 1894 it had again retreated to its limit of 1890. This glacier reaches tide water and ends in a vertical cliff of ice, 2.75 kilometers (9000 feet) long and 50 to 65 meters (150–215 feet) high; on each side of this cliff the glacier rests on the land and ends like an ordinary alpine glacier. The oscillation mentioned applies only

¹ This paper gives a more detailed description of the variations of the glaciers of this country than is contained in the Rep. of the Intern. Com. An excellent account of our present knowledge of these glaciers has been given by Professor Israel C. Russell in his recently published book, "The Glaciers of North America."

² Climatic Changes Indicated by the Glaciers of North America, by I. C. RUSSELL. Am. Geol., Vol. IX, 322–336.

³ Shores and Alps of Alaska, by H. W. STETSON KARR, p. 77.

⁴ Am. Geol., Vol. IX, 329. The best map of this region is in Russell's Second Expedition to Mt. St. Elias, 13th Ann. Rep. U. S. Geol. Sur., p. 6, or his Malaspina Glacier, this JOURNAL, Vol. I, p. 221.

⁵ An Expedition to the Yukon District, by WILLARD HAYES, Nat. Geog. Mag., Washington, 1892, Vol. IV, p. 153.

to the part facing the water; the sides have been steadily receding.¹

Mount Rainier is a volcanic cone, 4400 meters high, in the state of Washington, bearing on its steep slopes about a dozen glaciers from five to ten kilometers long. Information has reached me concerning the Carbon glacier on the northern, the Willis on the northwestern, and the Nisqually on the southern face of the mountain. All three of these glaciers are steadily receding.

Mr. Otto J. Klotz made a photographic study of the end of Baird glacier, Alaska (long. $132^{\circ} 50'$ N., lat. $57^{\circ} 8'$ W.) in 1894.² This will be the beginning of a careful record of the variations of this glacier.

In conclusion, the very incomplete data indicate that, with few exceptions, the glaciers of the United States are shrinking at the present time.

REPORT ON THE GLACIERS OF THE UNITED STATES FOR 1896.³

Cook's Inlet.—A glacier on the Kenai Peninsular has receded about 250 feet between 1880 and 1895.⁴ Mr. Dall writes that he thinks all the glaciers on the Pacific coast which he has personally visited are retreating.

Chilcat Pass.—The glaciers on the southern side of this pass are receding. (*J. E. Spur.*)

Glacier Bay region.—Mr. John Muir reports that he found Rendu and Carroll glaciers, at the head of the bay, from three to seven kilometers (two to four miles) shorter in 1896 than they were in 1879. Muir glacier also continues to recede.

¹ Studies of Muir Glacier, Alaska, by HARRY FIELDING REID, Nat. Geog. Mag. 1892, Vol. IV, pp. 33-42; and Glacier Bay and its Glaciers, 16th Ann. Rep. U.S. Geol. Sur., pp. 440-442.

² This JOURNAL, 1895, Vol. III, pp. 512-518. I recommend this article to observers as an example of how much of permanent value can be done in a short time by the photographic method.

³ A synopsis of this report will appear in the Second Annual Report of the International Committee.

⁴ W. H. DALL, Bull. Am. Soc., 1896, XXXVII, 15,

Mt. Rainier.—Professor I. C. Russell writes me :

In company with Bailey Willis and George Otis Smith of the United States Geological Survey, I visited Mount Rainier, Washington, and spent two weeks, from July 15 to August 1, in examining the glaciers on its sides.

The Willis, Carbon, Winthrop, Emmons, Nisqually, and Cowlitz glaciers were visited. Each of these furnishes clear evidence of having recently been lowered by melting, especially in the lower courses. The extremities of the three first named were examined and in each case a recent and marked recession was manifest.

The extremity of Carbon glacier, as judged by Willis, has receded about 100 meters since his former visit in 1881. The extremity of the glacier at the date mentioned was a vertical precipice of nearly clear ice, but now has a slope of 55° to 60° and is débris covered.

Willis glacier is divided at its terminus by a rugged boss of rock, for which I suggest the name Division rock, the down-stream face of which is a rugged precipice by estimate 120 or 150 meters high. I am informed by Willis, who saw it from below, that in 1883 the glacier broke off not far behind the summit of this precipice and formed walls of ice descending on each side of it. The ice did not cover the highest peak on Division rock at the date mentioned, and there are about ten small spruce trees growing on the apex. These trees are certainly more than fifteen years old. The upstream side of the rock, below the trees, is strewn with stones and dirt and has evidently been recently occupied by the glacier. At the time of my visit the ice in the central part of the glacier had receded 175 meters from the edges of the precipice. Fresh lateral moraines elevated from thirty to forty meters above the level of the glacier in 1896, and extending fully three kilometers (two miles) above Division rock, agree approximately with the 1883 level of the ice as reported by Willis.

Willis glacier now divides on reaching Division rock into two sharp-pointed tongues of débris-covered ice which end with low frontal slopes. The extremities of these tongues are about abreast of the summit of Division rock. Where the glacier divides a pyramidal monument of angular stones about one and one-third meters high is built. This monument records the limit of the ice at the place where it divides, on July 31, 1896.

Up stream from Division rock there is another similar eminence which might possibly be mistaken for it, if the glacier continues to recede. The rocky knob referred to is now a part of the right or northern wall of the glacier.

Eight hundred and forty meters, as measured by pacing, above the monument described above, there is an ice-fall in the glacier 130 to 135 meters high. The descent of the surface of the glacier from the base of the ice-fall

to the monument is 280 meters, by aneroid. The gradient becomes progressively steeper as one descends from the base of the ice-fall.

No marks were made to record the extent of the other glaciers visited.

Mount Hood, Oregon.—There are eight glaciers on this volcanic cone; all of them are steadily diminishing in size. The Eliot glacier on the north side of the mountain is about four kilometers (two and one-half miles) long and about 0.8 kilometer (one-half mile) wide; and shows a marked recession in the last three years. Before that the face was much steeper.¹ In the central part of the glacier near the end the velocity of movement has averaged about fifteen meters (fifty feet) a year since 1890. Coe glacier, which lies next to the Eliot on the west, is about four kilometers (two and one-half miles) long and 0.4 kilometer (one-quarter mile) wide. (*W. A. Langille.*)

Illecellewaet Glacier, Selkirk Mountains, Canada.—As there is at present no one on the committee representing the British colonies, I give what information I have concerning this glacier.²

Professor Charles E. Fay wrote me in 1895 that the glacier had receded since 1890, and markedly since 1894. Photographs taken by Messrs. Parker B. Field and Philip S. Abbot in 1895 and 1896, respectively, show that the recession continued last year.

There are prospects that more systematic observations of some of the glaciers of the Pacific slope may be begun next summer.

HARRY FIELDING REID.

GEOLOGICAL LABORATORY,
JOHNS HOPKINS UNIVERSITY,
April 8, 1897.

¹ Probably due to an advance.—H. F. R.

² Captain Marshall Hall, to whose interest and energy the international committee owes its existence, represented the British colonies until his sudden death in April 1896.